



# French National Report on Argo - 2023 AST 25

## **By the Argo-France Management Board :**

*X. André, C. Cabanes, T. Carval, H. Claustre, C. Coatanoan, F. D'Ortenzio, N. Kolodziejczyk, N. Lebreton, E. Leymarie, A. Poteau, R. Sauzède, C. Schmechtig, P.Y. Le Traon, N. Poffa, V. Thierry and J. Uitz*

### [Background, organization and funding of the French Argo activities](#)

[Organization](#)

[Funding](#)

[Long term evolution of Argo](#)

### [Float development](#)

#### [The status of implementation](#)

[Floats deployed and their performance](#)

[Technical problems encountered and solved](#)

[Status of contributions to Argo data management](#)

[Status of delayed mode quality control process](#)

### [Summary of deployment plans and other commitments to Argo for the upcoming year and beyond where possible](#)

[Operational ocean forecasting](#)

[Support to the Mercator and Coriolis scientific activities](#)

[European Argo-data project involving French Argo community](#)

#### [National Research](#)

[Key project activities](#)

[ISAS T/S gridded fields](#)

[ANDRO Trajectory dataset](#)

[BGC Products](#)

[ERC REFINE \(Robots Explore plankton-driven Fluxes in the marine Twilight Zone, 2019-2022\)](#)

[PIE Ifremer PIANO \(Argo Novel Observations Investment Plan : 2021-2025\)](#)

[Equipex+ Argo-2030 \(3rd Investment Plan of French Research Ministry: 2021-2028\)](#)

### [Bibliography](#)

[How has COVID-19 impacted your National Program's ability to implement Argo in the past year?](#)

[Does your National Program have any deployment plans for RBR floats in the next couple years?](#)



# Background, organization and funding of the French Argo activities

## Organization

Argo-France (<https://www.argo-france.fr>) gathers all the French activities related to Argo and its extension toward deep and biogeochemical measurements and marginal and polar seas. Argo-France is the French contribution to the Euro-Argo European research infrastructure (ERIC) that organizes and federates European contributions to Argo.

All Argo-France activities are led and coordinated by:

- a scientific committee shared with the CNRS/LEFE Group Mission Mercator Coriolis (GMMC),
- a [steering team](#)

Argo-France is part of the Ministry of Research national roadmap on large research infrastructure (IR\*). Argo-France operational activities are organized through the Coriolis partnership (IFREMER, SHOM, INSU, IRD, Météo France, CEREMA, CNES and IPEV). Two research laboratories are leading the Argo-France scientific activities: the "[Laboratory for Ocean Physics and Satellite remote sensing](#)" (LOPS, Brest, France) and the "[Laboratoire d'Océanographie de Villefranche](#)" / "[Institut de la Mer de Villefranche](#)" (IMEV/LOV, Villefranche-sur-Mer, France). Coriolis and Argo-France have strong links with Mercator Ocean International (the French operational ocean forecasting center).

## Funding

Argo-France is mainly funded by the ministry of Research through Ifremer as part of the national roadmap on large scale infrastructures and contribution to Euro-Argo (IR\*). This is a long term commitment. Argo-France is also funded through Ifremer, SHOM (Ministry of Defense), CNRS/INSU and other French institutes involved in oceanography (CNES, IRD, Météo-France), and by the Brittany and Provence Alpes-Côte d'Azur régions ([CPER projects](#)). The National Observation Services (SNO) Argo-France is supported by CNRS/INSU and the IUEM institute at University of Brest OSU (Observatory). The French contribution to the Argo global array is at the level of 60 to 65 floats per year with funding from Ifremer (50 to 55 floats/year) and SHOM (about 10 floats/year).

Since 2000, around 1600 French floats have been deployed in different geographic areas. Deployments focused on meeting specific French requirements while also contributing to the global array.

To complement Argo-France, the NAOS project (Novel Argo Ocean observing System, 2011-2019) was funded by the Ministry of Research to consolidate and improve the French contribution to Argo and to prepare the next scientific challenges for Argo. The project provided an additional funding of 15 to 20 floats per year from 2012 to 2019, which allowed Ifremer to increase its long-term contribution to Argo from 50 to 65-70 floats/year. NAOS also developed the new generation of French Argo floats and set up pilot experiments for biogeochemical floats (Mediterranean Sea, Arctic), Under Ice BGC floats (baffin bay) and deep floats (North Atlantic).

As follow up of this project:

- the [Ifremer PIANO project](#) (2021-2025) will consolidate and improve the French contribution to BGC-Argo (funding of 15 BGC floats) and develop the next generation

french of deep-Argo floats (6000m), and BGC-ECO floats (BGC float with ecological sensors).

- the ANR EQUIPEX+ [Argo2030 project](#) (2021-2028) has been recently launch (kick off meeting January 2022) and funded by the Ministry of research to consolidate and improve the French contribution to BGC-Argo (funding of 15 BGC floats), and to test the next generation of french deep-Argo-6000 floats (funding of 22 floats), and of BGC-ECO floats (funding of 14 BGC-ECO float).

The level of support, additional to float purchase, is as indicated in Tableau 1 (manpower for coordination activities, float preparation, deployment and data management activities).

| <b>Year</b> | <b>Funding</b> | <b>Man/Year</b> | <b>French floats</b> | <b>Co-funded EU floats</b> | <b>Total</b> |
|-------------|----------------|-----------------|----------------------|----------------------------|--------------|
| 2000        | 300k€          |                 | 11                   |                            | 11           |
| 2001        | 633k€          | 3               | 12                   |                            | 12           |
| 2002        | 980k€          | 6               | 7                    | 4                          | 11           |
| 2003        | 900k€          | 9               | 34                   | 20                         | 54           |
| 2004        | 1400k€         | 15              | 85                   | 18                         | 103          |
| 2005        | 450k€          | 15              | 89                   | 11                         | 100          |
| 2006        | 900k€          | 12              | 51                   | 14                         | 65           |
| 2007        | 900k€          | 12              | 36                   |                            | 36           |
| 2008        | 1200k€         | 12              | 90                   |                            | 90           |
| 2009        | 1200k€         | 12              | 35                   | 8                          | 43           |
| 2010        | 1400k€         | 12              | 59                   |                            | 59           |
| 2011        | 1400k€         | 12              | 64                   |                            | 64           |
| 2012        | 1400k€         | 12              | 105                  |                            | 105          |
| 2013        | 1400k€         | 12              | 89                   |                            | 89           |
| 2014        | 1400k€         | 12              | 108                  |                            | 108          |
| 2015        | 1400k€         | 14              | 131                  |                            | 131          |
| 2016        | 1400k€         | 14              | 57                   |                            | 57           |
| 2017        | 1400k€         | 14              | 69                   |                            | 69           |
| 2018        | 1400k€         | 14              | 86                   |                            | 86           |
| 2019        | 1400k€         | 14              | 71                   |                            | 71           |
| 2020        | 1400k€         | 15              | 45                   |                            | 45           |
| 2021        | 1400k€         | 15              | 90                   |                            | 90           |
| 2022        | 1400k€         | 15              | 43                   |                            | 43           |
| 2023        | 1400k€         | 15              | 74                   |                            | 74           |

|                      |               |           |           |    |           |
|----------------------|---------------|-----------|-----------|----|-----------|
| Total<br>(2000-2023) |               |           | 1541      | 75 | 1616      |
| <b>2024</b>          | <b>1400k€</b> | <b>15</b> | <b>70</b> |    | <b>70</b> |

Tableau 1: (*Man/year* column) Manpower dedicated to Argo for coordination activities, float preparation, deployment and data management activities (GDAC, DAC, NAARC, DMQC) within Argo-France. (*French floats* column) French floats contributing to Argo deployed by year. (*Co-funded EU floats* column) EU floats are the additional floats co-funded by the European Union within the Gyroscope, Mersea and MFSTEP projects. Estimated value is given for 2024.

## Long term evolution of Argo

At the national level, Argo-France will contribute to the new phase of Argo with about 55-60 floats/year with the following repartition:

- 20-25 core Argo floats /year
- 10-12 core Argo floats with O2 sensor /year
- 10-12 Deep-Argo-4000 floats /year (+ 22 Deep-Argo-6000 floats)
- 10-12 BGC-Argo floats /year (including BGC-ECO floats, see below)

Core T/S, deep floats and oxygen sensors will be funded until 2027 (National Research Infrastructure IR\* Euro-Argo France and [CPER Brittany region](#)), the biogeochemical mission is funded through different projects (CPER PACA and Brittany regions, ERC Refine, Argo-2030 and PIANO projects).

Argo-France strategy will be adjusted according to international recommendations with regard to the deep and BGC extensions. Euro-Argo has published a long term roadmap for the next phase of Argo and as part of the ERIC Euro-Argo countries will work on the implementation of a new sustained phase for Argo in Europe.

## Float development

As part of the [EA-RISE 2019-2022 H2020 project](#) (final meeting 29 november 2022):

- Two Deep-Arvor equipped with 2-CTDs (the RBRargoDeep|OEM and the SBE61) and two Deep-Arvor equipped with 3-CTDs (the RBRargoDeep|OEM, the SBE41 and the SBE61) were developed. Due to delay in sensor provisioning, the two 2-head floats were deployed in 2022. After first deployments in 2020, a 3-head float with the new design of the RBRargoDeep|OEM sensor were deployed in 2022. A publication gathering the results will be submitted in 2024.
- Two Provor floats with SUNA + OPUS + O2 + EcoTriplet and with OC4 + RAMSES + O2 + EcoTriplet are developed, tested in the Mediterranean Sea and will be deployed in the Baltic.

As part of the [ERC REFINE project](#) (see details in the National research section) technological developments are expected to provide BGC-Argo:

- Extended battery packs for longer mission
- New electronic for targeted exploration and adaptative sampling
- New sensors for particles and zooplankton characterization

As part of the new [Ifremer PIANO project](#) the expected technological developments are :

- New T/S and BGC sensors (optical sensors, micro-sonar, chemical sensor)
- improvement of Deep-Argo 4000 and development of new Deep-Argo 6000 m
- Improve float technology (communications and electronics)

- Test of a Deep-Arvor float with two oxygen sensors: Aanderaa optode and RINKO sensor. Two prototypes are now qualified and will be deployed during the CROSSROAD mission in August 2024.

## The status of implementation

### Floats deployed and their performance

68 floats have been deployed by France in 2023 (37 T/S Core, 3 T/S/O2, 24 BGC, 4 DEEP). We deployed those floats from French RVs Atalante, Thalassa, Marion Dufresne and Beautemps Beaupre, international RVs Sonne, Amundsen and Sarmiento de Gamboa but also from ships of opportunity (commercial ship, fishing vessels and sailing yachts Tara and Iris). The deployment areas are chosen to meet French requirements in terms of research and operational activities and also to contribute in establishing the global array (especially in the Southern Ocean) using OceanOPS tools.

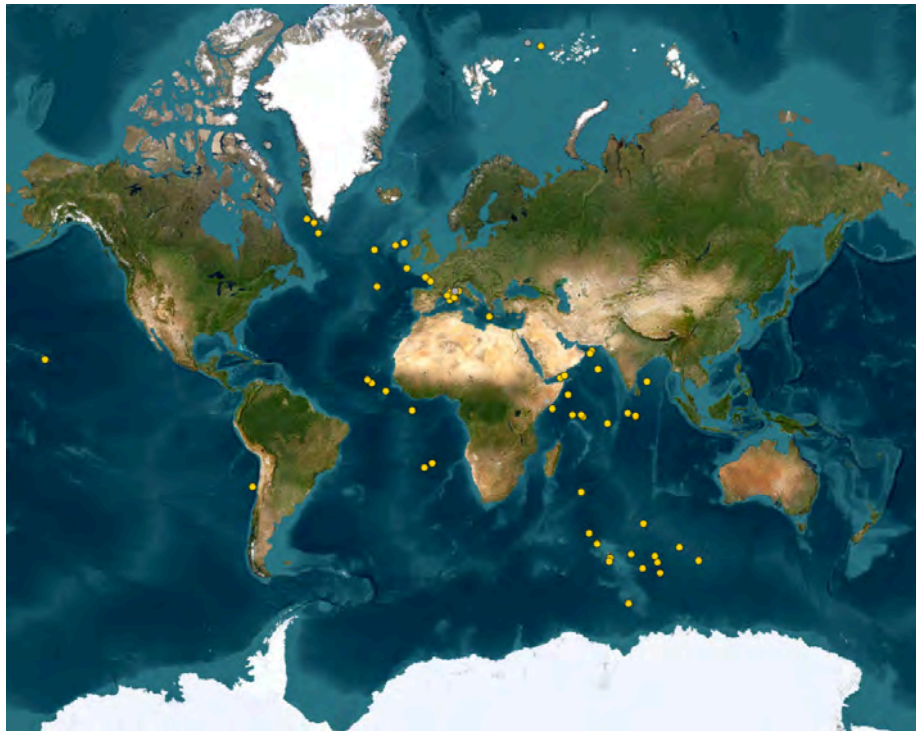


Figure 1 : Deployment locations of Argo-France floats in 2023 by float types.  
In January 2023, among 68 floats deployed in 2023 :

- 62 are active
- 4 are under ice
- 1 BGC Provor has disappeared after 1 single cycle and 1 Arvor is no more operational due to CTD failure.

The French Argo fleet operated in 2023 includes **67% of core, 12% of deep, 5% of T/S/O2 et 16% of BGC. 75 french floats died in 2023, mainly due to end of battery (~75%). Floats lifetime is on average of 3.9 years.**

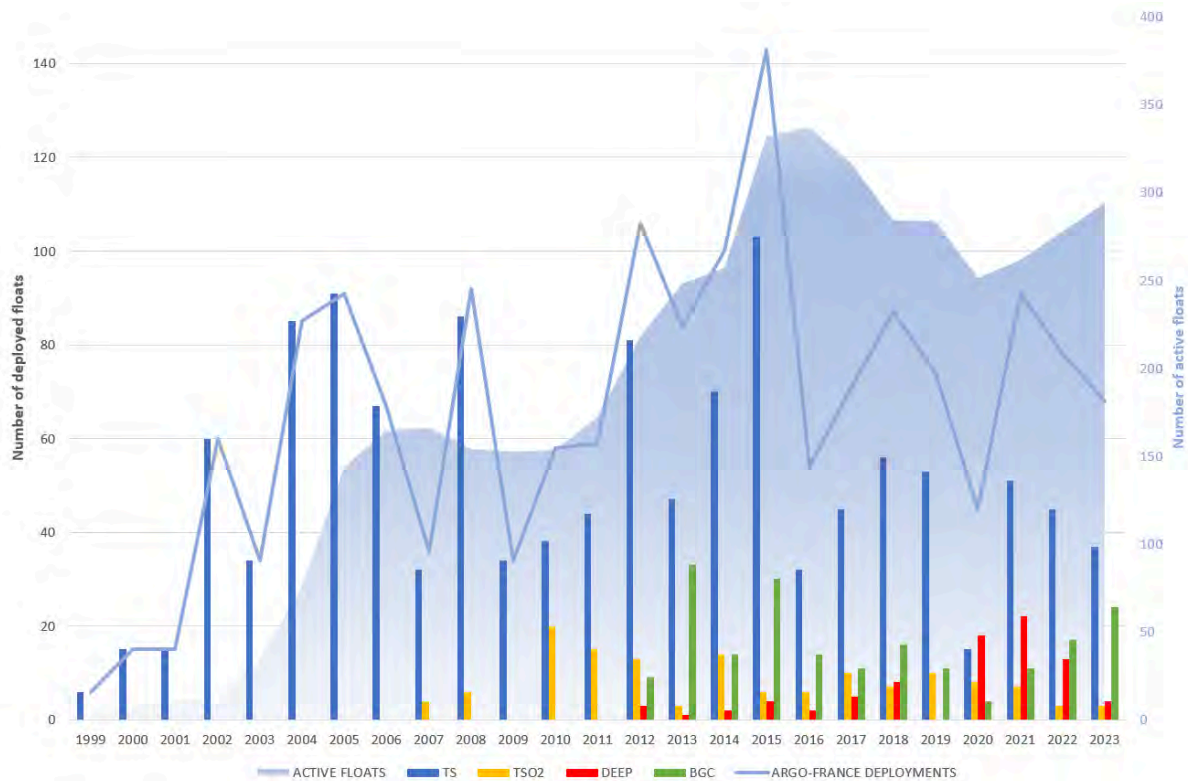


Figure 2 : Argo France fleet deployment since 1999.

The National Strategy for Argo Global Network Profiling floats deployments is a document of recommendation, including the most recent recommendations from AST, for GMMC scientific board and Argo France community : <https://doi.org/10.13155/59297>.

## Technical problems encountered and solved

### Technical problems.

#### Seabird batch of drifting CTDs is being assessed and monitored.

Since 2014, a larger than expected percentage of SBE conductivity sensors have drifted prematurely, eventually to an uncorrectable state (Abrupt Salty Drift - ASD). Changes at the manufacturing level were introduced in 2018 to reduce such occurrences. To monitor this issue, floats affected are listed in a spreadsheet that is concatenated at the international level and updated regularly:

<https://docs.google.com/spreadsheets/d/1TA7SAnTiUvCK7AyGtSTUq3gu9QFbVdONj9M9zAq8CJU/e/dit#gid=0>

So far, 91 [French Floats are listed](#) as having a moderate or severe drift, this represents about 7% of the french float affected by this failure.

Argo-France is also participating in an international working group tasked with monitoring the problem of abrupt salinity drift (ASD), which has appeared on manufactured SBE sensors since 2014. Indeed, there is a larger proportion of sensors that are subject to premature salinity drift, and whose data quickly becomes unusable. Argo-France has contributed to a paper (Wong et al, 2023: <https://doi.org/10.5194/essd-15-383-2023>) describing the salinity bias in the raw Argo dataset and



validating the delayed-time dataset to quantify residual errors and regional variations in salinity uncertainties.

## Status of contributions to Argo data management

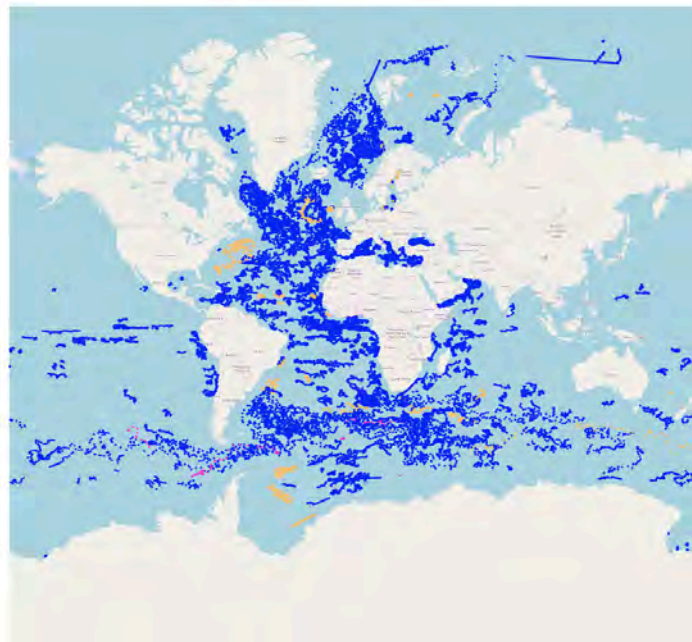
Within Argo-France, data management is undertaken by Coriolis data center, which plays three roles: Data Assembly Centre, Global Data Centre, and leader of the Atlantic Argo Regional Centre. Coriolis is located within Ifremer-Brest and is operated by Ifremer with support of SHOM. Since 2016, the BGC floats processing chain has been fully operational and integrated within the Coriolis data management stream.

All Argo data management details are in the Coriolis DAC and GDAC 2023 annual report (english) : <https://doi.org/10.13155/96772>

### Data Assembly Center

Coriolis processes in Real Time and Delayed Mode float data deployed by France and 7 European countries (Germany, Spain, Netherlands, Norway, Italy, Greece, Bulgaria).

In the last 12 months, 62 155 profiles from 923 active floats were collected, controlled and distributed. Compared to 2022, **the number of profiles slightly decreasing (-4%), the number of floats increased by 4%**. These figures illustrate a good momentum in Coriolis DAC activity. The 923 floats managed during that period had 48 versions of data formats.



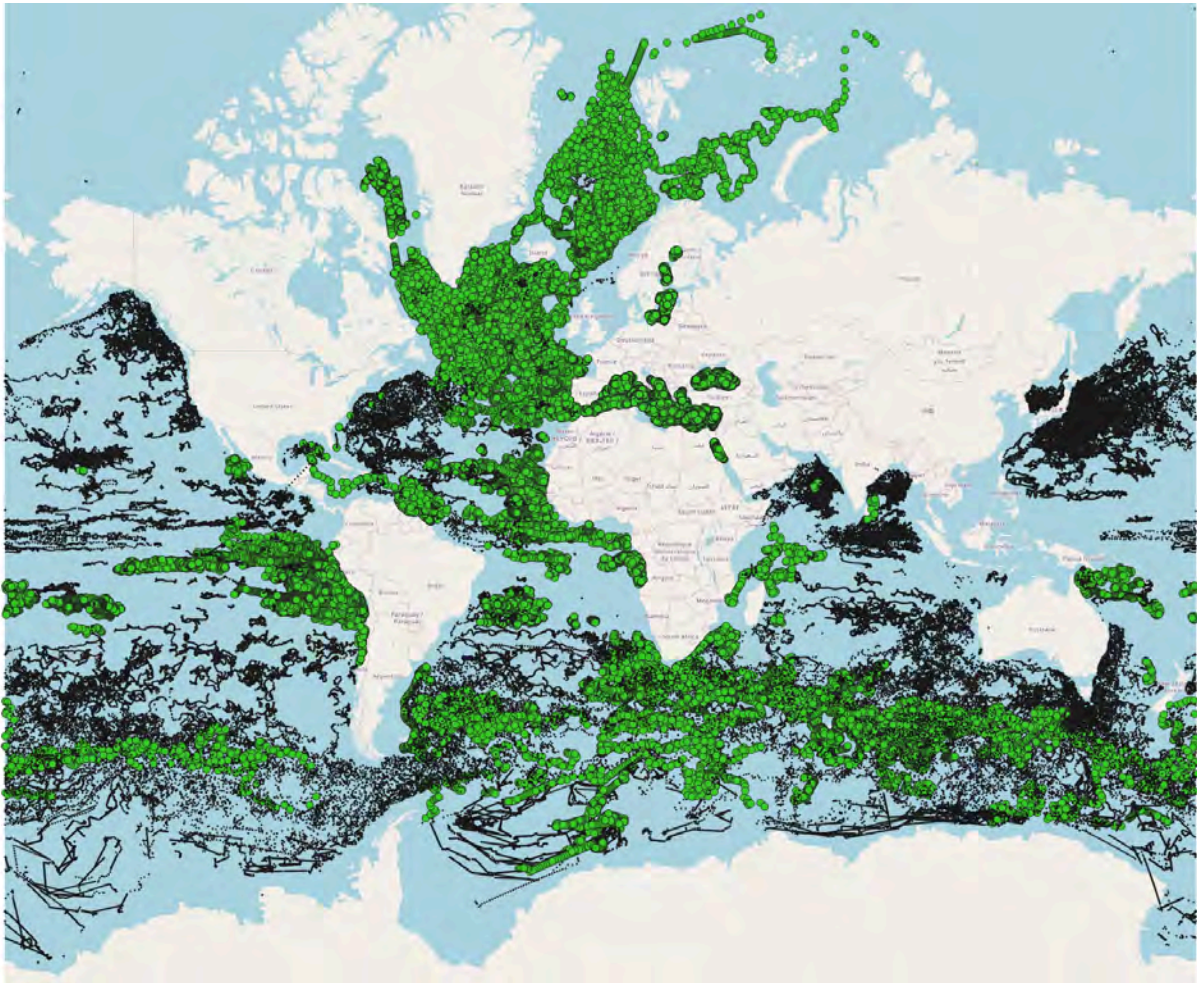
Map of the 62 155 profiles from 923 active floats decoded by Coriolis DAC this current year  
Apex Nova Provor

The data processing chain based on Matlab to manage data and metadata from Coriolis BGC-floats is continuously improved. These are advanced types of floats performing bio-geo-chemical (BGC) measurements.

- Coriolis DAC manages 733 BGC-Argo floats from 5 families. They performed 108 444 cycles.



- The data processing chain is freely available: Coriolis Argo floats data processing chain, <http://doi.org/10.17882/45589>



Map of the 733 BGC-Argo floats managed by Coriolis DAC (grey dots: the others DACs bio-Argo floats). They measure parameters such as oxygen, chlorophyll, turbidity, CDOM, back-scattering, UV, nitrate, bisulfide, pH, radiance, irradiance, PAR.

### Global Argo Data Centre

Coriolis hosts one of the two global data assembly centres (GDAC) for Argo that contains the whole official Argo dataset. Ifremer manage a dashboard (Semaphore) to monitor data distribution and give credit to data providers such as Argo floats: <https://audience-argo.ifremer.fr>

FTP, HTTPS and ERDDAP downloads log files are ingested in an Elasticsearch index. A link between downloaded files, download originators, floats included in the downloaded files and institution owners of the floats is performed. These links are displayed in a [Kibana dashboard](#). This dashboard offers the possibility to give credit to Floats owner institutions such as how many data from one particular institution was downloaded, by whose data users.

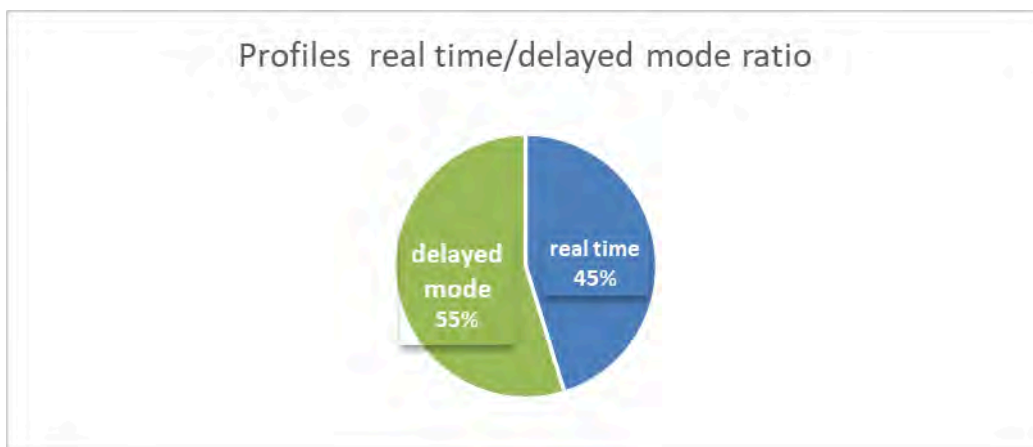
### Atlantic Argo Regional Centre

See section 5.4

## Status of delayed mode quality control process

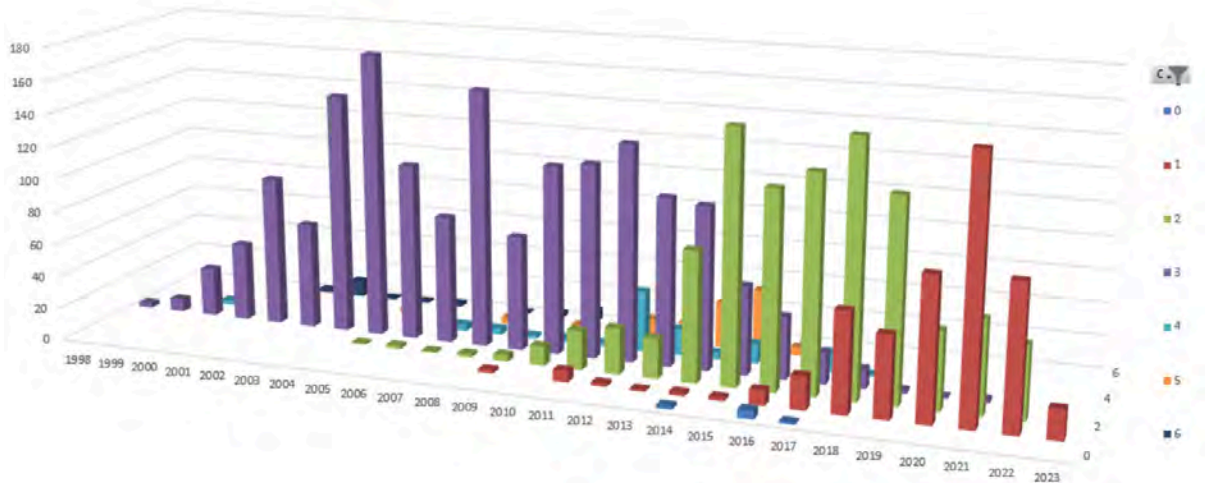
An Argo delayed mode profile contains a calibrated salinity profile (psal\_adjusted parameter).

- A total of **108 689 new or updated delayed mode profiles** was sent to GDACs this year.
- **A total of 383 908 delayed mode profiles** were sent to GDACs since 2005.  
The number of delayed mode profiles increased by 1% this year compared to 2022.



[Status of the floats processed by Coriolis DAC. In terms of profile percent \(DM available\)](#)

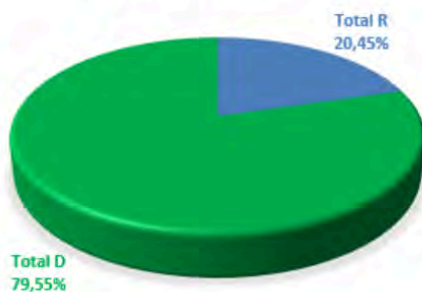
The status of the quality control done on the Coriolis floats is presented in the following plot. For the three last years (2020-2023), most of the floats are still too young (code 1) to be performed in delayed mode. For the years 2012 to 2016, we are still working on the DMQC of some floats. The codes 2 and 3 show the delayed mode profiles for respectively active and dead floats.



Status of the quality control done on profiles sorted by launch's year, code 1: young float, code 2: active float, DM done, code 3 : dead float, DM done; code 4 : DM in progress, code 5 : waiting for DM, code 6 : problems with float.

Looking in more detail to focus on BGC or Deep Argo data, a great effort has also been made to increase the count of mode profiles: at least 79% of floats are in DM, 48% of floats have one parameter in D mode for BGC profiles, and 58% of Deep Argo floats have been processed in delayed mode.

**CORE PROFILES**



**BGC PROFILES**



**DEEP FLOATS - NUMBER OF PROFILES**

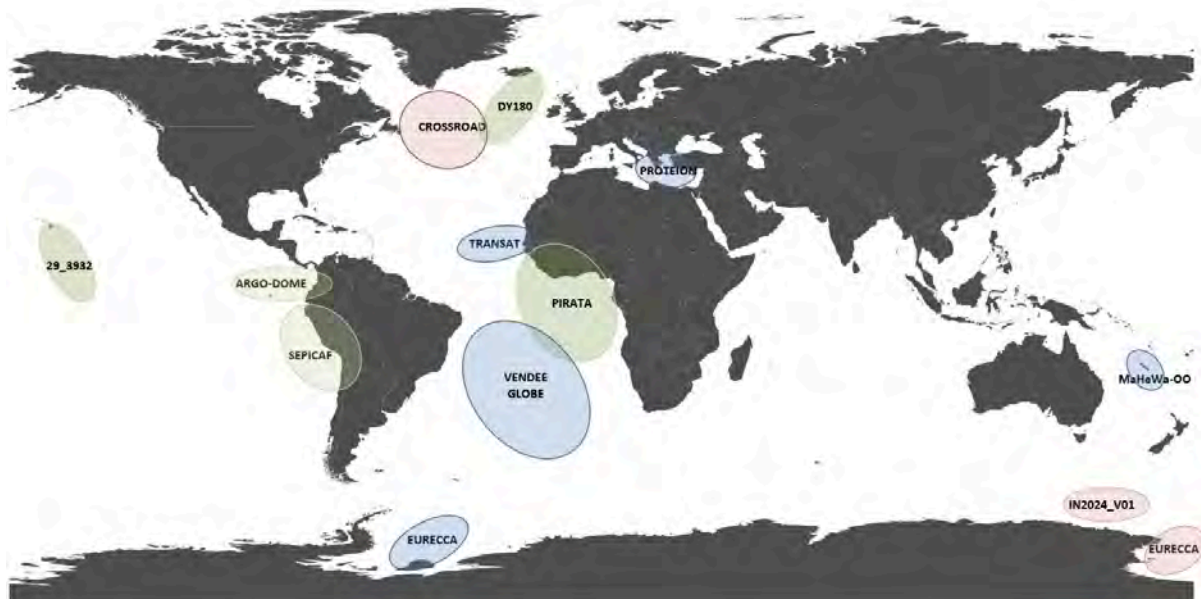


# Summary of deployment plans and other commitments to Argo for the upcoming year and beyond where possible

According to the current deployment plan, 70 to 80 floats are scheduled to be deployed in 2024 (40 T/S, 7 T/S/O2, 7 BGC, 12 DEEP), see map below.

Coriolis will continue to run the Coriolis DAC and the European GDAC as well as coordinating the Atlantic ARC (A-ARC) activities. Within Euro-Argo, development will be carried out to improve anomalies detection at GDAC both in RT and DM, to monitor in real time the behaviour of the European fleet and to improve data consistency check within A-ARC.

France also will continue to contribute to the funding of the AIC.



Deployment locations of Argo-France floats planned in 2023 by ship cruises : blue are core Argo deployments and greens will include BGC floats.

## Summary of national research and operational uses of Argo data as well as contributions to Argo Regional Centers

### Operational ocean forecasting

All Argo data (alongside with other in-situ and remotely sensed ocean data) are routinely assimilated into the MERCATOR operational ocean forecasting system run by the MERCATOR-Ocean structure. MERCATOR also operates the Global component of the European Copernicus Marine Environment Monitoring Service ([CMEMS](#)).

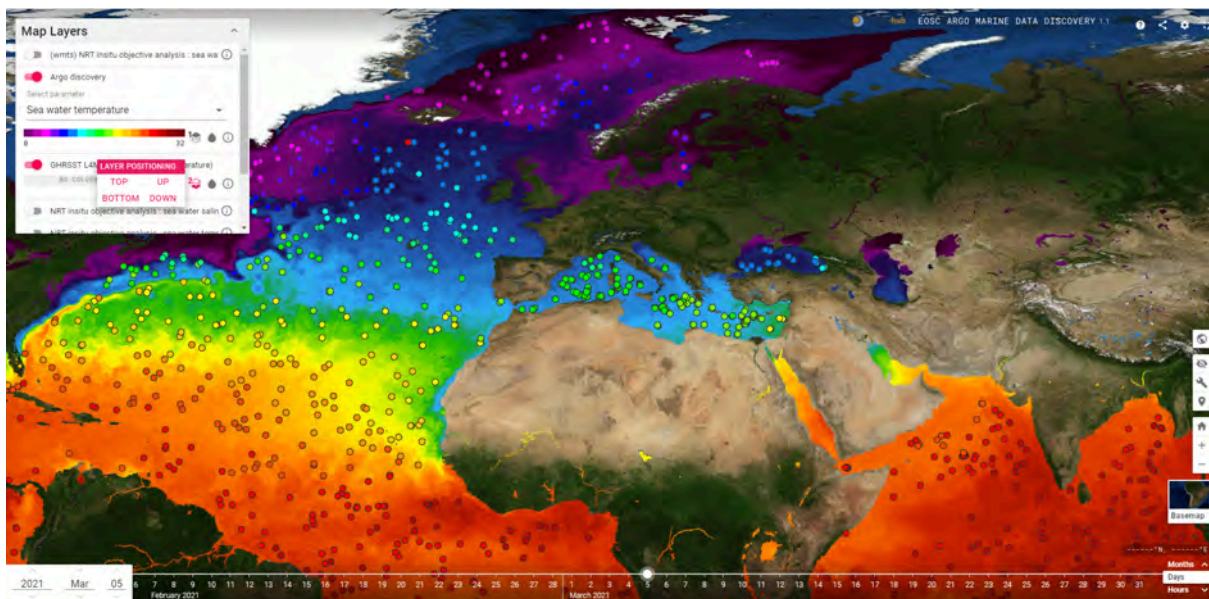


## Support to the Mercator and Coriolis scientific activities

Coriolis has developed together with MERCATOR (The French operational oceanography forecast center) a strong connection with the French research community via the Mercator-Coriolis Mission Group (GMMC). It consists of about one hundred researchers (with some turnover each year) following a scientific announcement of opportunities and a call for scientific proposals. Its task is to support the Mercator and Coriolis scientific activities and to participate in product validation. The call for scientific proposals proposes to the community Core, BGC and Deep Argo floats. These new opportunities strengthen the link between the French scientific community and Coriolis with regard to the development of qualification procedures for "Argo extensions" floats.

## European Argo-data project involving French Argo community

- ENVRI-FAIR: connecting ERICs (Euro-Argo) to EOSC Blue Cloud:
  - Improving data access to European data base including Argo dataset through new API on Coriolis GDAC
  
- EOSC-Blue cloud
  - Improving visualization tools for Argo data combined with satellite information (<http://bluecloud.odatis-ocean.fr/>)



Map of Argo-Float surface temperature overloaded with satellite SST

## National Research

Argo data are being used by many researchers in France to improve the understanding of ocean properties (e.g. circulation, heat and freshwater storage and budget, and mixing), climate monitoring and on how they are applied in ocean models (e.g. improved salinity assimilation, ...).

A list of France bibliography is available at the end of this report.

## Key project activities

### ISAS T/S gridded fields

Argo France provide updated T/S gridded monthly fields from Argo profiles and some other CTDs (CCHDO, ICES, PIRATA-TAO-RAMA, MEOP, ITP, ...). ISASO2 also provide mean fields of DO over the Argo period. All the ISAS releases have been now accessible from an unique DOI:

Kolodziejczyk Nicolas, Prigent-Mazella Annaig, Gaillard Fabienne (2023). ISAS temperature, salinity, dissolved oxygen gridded fields. SEANOE. <https://doi.org/10.17882/52367>

### ANDRO Trajectory dataset

Argo-France contributes to the DMQC on Argo float trajectories and provides updates to the ANDRO product (Atlas of Argo trajectories). An update for the period 2010-2022 including the floats of the AOML and Coriolis DACs was published in 2022. The delayed-time QCs of the Argo float trajectory data have been updated, as well as the Andro Atlas of float travel velocities at DOI:

Ollitrault Michel, Rannou Philippe, Brion Emilie, Cabanes Cecile, Reverdin Gilles, Kolodziejczyk Nicolas (2022). ANDRO: An Argo-based deep displacement dataset. SEANOE. doi:<https://doi.org/10.17882/47077>

### BGC Products

Argo-France adds value to BGC-Argo data by making several products operationally available and updating them annually (as a minimum) in Copernicus Marine Service.

The first product is a globally interpolated product of Chlorophyll-a and particulate backscatter coefficient, transformed into particulate organic carbon: <https://doi.org/10.48670/moi-00046>. This product provides quarter-degree fields with weekly resolution over the period 1998-2022, as well as monthly resolution for climatological products. This product is derived from the machine learning method SOCA (for Satellite Ocean Color and Argo data to infer bio-optical properties to depth; Sauzède et al. 2016; Sauzède et al. in prep.).

A second product of vertical profiles of nutrient concentration (nitrates, phosphates and silicates) and carbonate system variables (total alkalinity, dissolved inorganic carbon, pH and partial pressure of carbon dioxide) is distributed and updated annually in Copernicus Marine Service: <https://doi.org/10.48670/moi-00048>. These profiles are estimated from neural networks for each Argo float equipped with an oxygen sensor, whose data are qualified in delayed time. These neural networks come from a family of methods called CANYON (for Carbonate system and Nutrients concentration from hYdrological properties and Oxygen using a Neural-network; Sauzède et al., 2017; Bittig et al. 2018). The regional CANYON-MED neural network is used for data in the Mediterranean Sea (Fourrier et al. 2020).

As part of the development of such products, a SCOR (Scientific Committee on Oceanic Research) working group was accepted at the end of 2023. This working group, entitled 4D-BGC SCOR (WG #168), is chaired by Raphaëlle Sauzède (Argo-France) and Jonathan Sharp (USA) and comprises 19 other members, representing 14 different countries.

### ERC REFINE (Robots Explore plankton-driven Fluxes in the marine Twilight Zone, 2019-2022)

After obtaining a first ERC in 2011 ( remOcean ), Hervé Claustre obtained in 2019 a second ERC (Advanced Grant) for the REFINE project . The scientific objective of REFINE is to understand and quantify the physical, biological and biogeochemical processes that control the biological carbon



pump, a key element in CO<sub>2</sub> sequestration. It is in the mesopelagic zone (or twilight zone), between 200 m and 1000 m, that most of the key processes occur. Yet this zone represents one of the least well known ecosystems on our planet. The REFINE project will therefore focus on exploring the meso-pelagic zone and will be implemented through four major coordinated actions:

1. Development of a new generation of multidisciplinary profiling floats, focusing in particular on the composition of phyto- and zooplankton communities.
2. Realization of ~4 years of robotic studies in five ocean areas, representative of the diversity of biogeochemical conditions and responses to climate change in the world ocean, on a continuum of time scales from diurnal to interannual.
3. In-depth analysis of the REFINE dataset, enabling carbon flux budgets to be established for each of the five areas, and understanding the physical and biogeochemical mechanisms involved in the transfer of organic carbon to the deep ocean.
4. "Upscaling" regional processes to the global ocean, notably through the use of artificial intelligence that takes advantage of multi-source observations from REFINE robots and Earth observation satellites.

### PIE Ifremer PIANO (Argo Novel Observations Investment Plan ; 2021-2025)

The objective of the PIE PIANO project (Argo New Observations Investment Plan) is to carry out innovative technological developments on Argo floats, on sensors (for T/S and BGC-Argo) and to implement the French contribution to the new Argo phase over 2021-2027. This will involve:

- procurement of BGC-Argo floats (12 floats over 5 years)
- to develop a French offer of BGC sensors (active optics, passive optics, micro sonar and pH chemini)
- to develop a Deep-Argo 6000 m float
- to improve float technology (electronics, communication)
- finally to ensure the processing of project data including the development of innovative methods

### Equipex+ Argo-2030 (3<sup>rd</sup> Investment Plan of French Research Ministry; 2021-2028)

The objective of the Equipex PIA3 Argo-2030 project is to acquire BGC floats to consolidate the French contribution to the BGC component of the Argo network (15 floats, i.e. 2-3 floats/year over 8 years). Argo-2030 also plans scientific experiments to test and validate the new generations of BGC and Deep floats developed in complementary projects (ERC Refine for the platform, PIE Ifremer PIANO for "Made in France" sensors) :

- The new generation of French BGC-Argo floats (referred to as "BGC-ECO" Argo) will add unique imagery and active acoustics capabilities. These floats will allow the exploration of the mesopelagic zone (100-1000 m) including its biological/fishing dimension (it is believed that the protein resources of this zone are underestimated by at least an order of magnitude) assuming that it is the main site of the remineralization of CO<sub>2</sub>, and therefore it is decisive for CO<sub>2</sub> sequestration.
- The new generation of French Deep-Argo float targets 6000 m depth. . It will offer a high capacity for carrying additional sensors (oxygen in particular), allowing this float to be positioned as the first Deep + BGC mixed float. They will help estimate the role of the deep ocean on the planet's energy balance, sea level rise, deoxygenation, and acidification in key regions (Atlantic, Southern Ocean). Their deployment will be combined with Deep-Argo 4000 floats to best resolve geographic structures and seasonal to interannual variations in heat and freshwater content, steric height and circulation at the basin scale within deep (> 2000 dbar) and abyssal (> 4000 dbar) oceanic layers.

## Argo-Regional Center: Atlantic

France leads the A-ARC, which is a collaborative effort between Germany (IFM-HH, BSH), Spain (IEO), Italy (OGS), Netherlands (KNMI), UK (NOCS, UKHO), Ireland (IMR), Norway (IMR), Canada (DFO), and USA (AOML), Greece (HCMR) and Bulgaria (IOBAS). Coriolis coordinates the Atlantic ARC activities and in particular the float deployment in Atlantic.

1903 floats that have been processed in delayed time in the Atlantic ARC, north of 35°S, with a check made using a modified OW method that has been published by Cabanes et al (<http://dx.doi.org/10.1016/j.dsr.2016.05.007>). Floats for which it may be necessary to revise the original DM correction are reported to PIs. The list is available online at:

<http://www.umr-lops.fr/en/SNO-Argo/Activities/NAARC/Consistency-checks-of-DM-salinity-correction>

S

## Issues that your country wishes to be considered and resolved by the Argo Steering Team regarding the international operation of Argo.

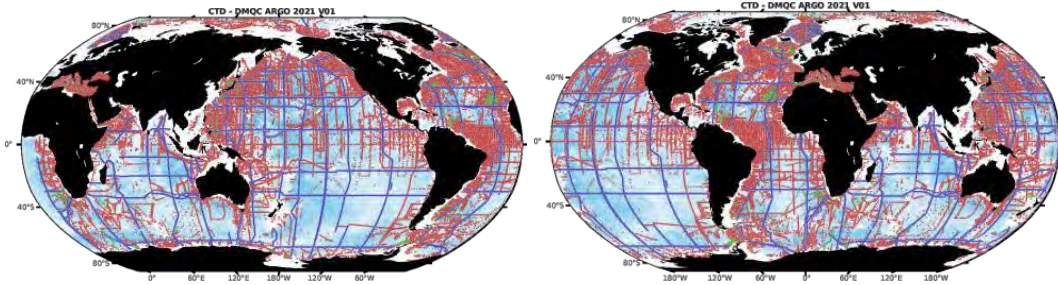
*These might include tasks performed by the AIC, the coordination of activities at an international level and the performance of the Argo data system. If you have specific comments, please include them in your national report.*

- Increase of the float's prices under flat funding from project and IR\* Argo France may reduce the number of purchased float in the next years
- No funding identified beyond 2027-2028 for Deep and BGC extensions

## CTD cruise data in the reference database

*To continue improving the number of CTD cruise data being added to the reference database by Argo PIs, it is requested that you include the number and location of CTD cruise data uploaded by PIs within your country to the CCHDO website in the past year. These cruises could be used for Argo calibration purposes only or could be cruises that are open to the public as well.*

In March 2021, an updated version 2021V01 was provided including the GO-SHIP EASY ocean data product (16231 stations) for the DEEP baseline. Where the GO-SHIP profile from the CCHDO existed in the previous version, it has been replaced by the easy product version (higher QC version). In the reference database, this data can be identified with the GSD QCLevel (for GO-SHIP Deep Argo).



Version 2021V01: **GSD Easy-Ocean**, **GSH GO-SHIP** and **Others**

In mid-December 2021, a new version 2021V02 has been provided with minor corrections, following the feedback received by the users. Some CTDs have also been added: CTDs provided by scientists, CTDs made during float deployments and some GO-SHIP CTDs retrieved from the CCHDO website.

No update in 2023, but a new version is in preparation and will include updates from ocean climate library, CTD from CCHDO (confidential and GO-SHIP data), CTD from deployment, data from PANGEA and CTD provided by scientist (Arctic area).

Coriolis manages the Argo reference databases for the DMQC (CTD boat casts and Argo floats). In order to facilitate access by QC software, Ifremer undertakes to serve these databases via the ERDDAP API: <https://www.ifremer.fr/erddap/info/ArgoFloats-ref/index.html>. For the moment, only Argo reference data is available (because it is freely accessible). Ship data will also be provided via a simple authentication system. The new Argo simplified data access library (such as Argopy library) also provides access to reference data.

## Bibliography

*List of publications in which a scientist from a French laboratory is involved*

In 2023, at least 48 articles with a scientist affiliated in France as a coauthor have been published in peer-reviewed journals and 6 PhD thesis. Note that the list of all publications in which a scientist from a French laboratory is involved is available on the Argo France website and on the Argo Bibliography web page. To date, more than 400 articles have been listed:

<https://www.argo-france.fr/en/Bibliography/Publications>

## How has COVID-19 impacted your National Program's ability to implement Argo in the past year?

N/A

## Does your National Program have any deployment plans for RBR floats in the next couple years?

In 2022, 15 Arvor RBR were purchased and 8 of them deployed in 2023. All were upgraded with a new software allowing transmission of 1hz data sampling in order to test the thermal inertia correction and to provide more robust bin-averaged data as more data points will be included in typical 2-dbar bin compared to the current sampling rate (0,1 Hz). 19 Arvor-RBR were purchased in 2023. In addition, NKE has released an updated software allowing corrected/uncorrected 1Hz salinity transmission to better understand the sensor response at sea in the Argo context. This updated software is now available and the 3 first Arvor RBR of this version have been purchased by RBR and will be deployed by Argo-France in 2024. In 2024, we expect to buy about half of the French core Argo fleet with a RBR CTD.



New RBR CTD mounted on the head of the Arvor float (left) and deep-Arvor prototype equipped with 3 CTDS: RBR, SBE41 and SBE61 (right).



Qualification of the Deep-Arvor profiling float, equipped with both Aanderaa 4330 and Rinko AROD-FT oxygen sensors, for in situ comparison purposes.

---

Argo-France: <https://www.argo-france.fr/>

French bibliography: <https://www.argo-france.fr/en/Bibliography/Publications>

Argo PhD list: <https://www.argo-france.fr/Bibliographie/Theses>

A-ARC data mining website: <https://www.umr-lops.fr/SNO-Argo/Activities/A-ARC>

Coriolis Argo Download (doi):

<https://www.coriolis.eu.org/Data-Products/Catalogue#/metadata/3df904de-e47d-4bf9-85a0-7c0942aff8b6>

Coriolis DAC/GDAC: <https://www.coriolis.eu.org/Observing-the-Ocean/ARGO>

IUEM OSU: <https://www-iuem.univ-brest.fr/observation/Argo2030>

project : <https://www.argo-france.fr/en/Projects/Argo-2030>

PIANO project : <https://www.argo-france.fr/en/Projects/PIE-PIANO>

NAOS project: <http://www.naos-equipex.fr>

Euro-Argo: <http://www.euro-argo.eu>

Coriolis: <http://www.coriolis.eu.org>

Laboratoire d'Océanographie Physique et Spatiale: <http://www.umr-lops.fr/>

Laboratoire d'Océanographie de Villefranche: <http://www.obs-vlfr.fr/LOV>

Mercator: <http://www.mercator-ocean.fr>